may therefore be safely regarded as the measure of the total nitrogen, and as forming 90 per cent. of it.

Note.—An exception to this, of course, is found in the rare cases of acute yellow atrophy of the liver, but even in these cases it is doubtful whether the replacement of the urea by leucin and tyrosin is a constant phenomenon. In one case,* which clinically presented the features of acute atrophy of the liver, and in which, *post mortem*, the liver was found in the condition of acute fatty atrophy, the urea was still normally formed, leucin and tyrosin being absent.

Table II.—Showing the Percentage of Urea-Nitrogen in the different Groups of Cases.

Pneumonia (6 cases)	90·0
Jaundice (Case 1)	85·7
,, (Case 2)	90·2
Albuminuria (2 cases)	86·0
Collected cases	93·8
Dieted cases	90·1
Mean of all	89·3

Mean, excluding the jaundice and albuminuria cases, 91·3.

V. "On the Amount of Nitrogen excreted in the Urine by Man at Rest. No. II." By Samuel West, M.B. Oxon., and W. J. Russell, Ph.D., F.R.S. Received May 6, 1880.

Two methods of investigation have been adopted in inquiries of this kind. The first by stopping the ingestion of nitrogen, either by absolute deprivation of food, *i.e.*, by starvation, or by the giving of non-nitrogenous food. The second by reducing the ordinary diet to the lowest possible limit compatible with health. To the first objection may be made that the experiments are violent, and cannot be long maintained, and that they subject the body to most abnormal conditions. Such violence to the ordinary chemistry of the body produces its evidence in the excretions. The nitrogen in the urine under these circumstances varying even more irregularly and widely than under normal conditions, and the short possible duration of the experiments rendering the conclusions drawn, from the small number of observations, unsatisfactory.

From all these objections the second course of investigation is free, no violence is done to the body, and the observations may be prolonged

* "Pathol. Soc. Trans.," 1880.

ad libitum. And here two courses are open, both of which lead in the same direction, though starting from opposite sides. The one which consists in taking, as Playfair and Edward Smith have done, the minimum diets upon which life has been sustained, and estimating in them the amount of nitrogen present. The other in reducing the diet to the lowest possible limit until physiological equilibrium is established, and then estimating in the urine the amount of nitrogen excreted. It is this latter course which we have followed.

The three cases we have examined were patients suffering from the same affection, viz., aneurism, a disease which produces mechanical rather than constitutional symptoms, and in these cases, so long as the treatment was carried on, produced no symptoms at all, so that for all practical purposes the patients may be regarded as healthy men. They were all placed under the conditions of the most absolute rest, not being allowed to sit up in bed, or even indeed to feed themselves. Their diet was then reduced till it was found that the health was suffering, and then increased until a condition was reached, which may be called one of "clinical equilibrium," when the health so far as could be determined clinically was perfect.

The condition of clinical equilibrium being reached, the amount of nitrogen in the food was determined by direct analysis.

In two of the cases the diet consisted of ten ounces of solids and ten ounces of liquids, distributed as follows :—

Meat	4 ozs.	Water.....	4 ozs.
Bread.....	3 „	Wine	3 „
Potatoes.....	2 „	Tea.....	3 „
Butter.....	1 „		
	10 ozs.		10 ozs.

By calculation from Parkes' tables, this should yield 6·3 grms. of nitrogen. Analysis gave a somewhat higher number: in the first determination 7·07, and in the second 6·95. Cf. Tables IV and V.

In the third case the diet was 8 ozs. of solids and 8 ozs. of liquids, distributed in the same proportion. This by calculation from the preceding analysis should give about 5·6 grms. of nitrogen.

The analysis of the urine was made in the way described in the preceding paper. The tables give the result of 17 determinations.

Comparing now the amount of nitrogen ingested in the food, with the amount obtained from the urine, we find (Table V) :—

	Nitrogen ingested.		Nitrogen in urine.
Case I	7·0	.....	8·6
„ II	7·0	.....	8·64
„ III.....	5·6	.....	6·4

In all the cases the amount in the urine is in slight excess of that in the food, so that we may fairly regard all the nitrogen here obtained as representing tissue waste, for there was no surplus in the food to increase the amount in the urine.

We obtain as the mean of these three cases $\frac{23{\cdot}64}{3}=7{\cdot}87$, or approximately 8 grms., which we therefore are justified in regarding as the minimum amount of nitrogen a healthy adult man excretes per diem. This is equivalent to 17 grms., or 260 grains of urea.

The weights of the patients could not of course be determined, but the first two weighed it is supposed about 140 lbs., the third about 130 lbs., at the time of the observations, which was in each case after the dieting had lasted already three or four weeks, the total durations of the treatment being about ten weeks.

It is interesting to compare with these observations the results obtained by the other methods of the investigation above referred to.

*I. Ranke repeated upon man the experiments which Bischoff and Voit had conducted upon the dog, and among them are two series of observations which illustrate the subject at present under consideration.

In the first no food at all was given, and the patients were kept at rest.

In one case 8 grms. of nitrogen were passed, in a second 10, and in a third 8·6. In a fourth case the amount was as low as 6†. And in another series of observations upon himself, Ranke found the amount passed in two starvation days to be 8 and 8·6 grms.

Nicholson made three estimations in the case of starving prisoners, and found as the mean of three days 8·6 grms‡.

Many other observers have noticed the rapid fall in the amount of nitrogen excreted during starvation.

(From 28 grms. to 14. "Moos. Henle Zeitschr.," vii, 291),
„ 30 „ 14. Schneller, "Schmidt's Jahrbuch," 1856, 10, p. 10.
„ 33 „ 14. Brattler, "Beitrag zur Urologie," München, 1856, p. 6.)

But the short duration of these experiments makes it probable that the minimum was not reached.

We have then 8 grms. as the mean of the only reliable determination at our command of the nitrogen excreted in the urine during starvation.

* Kohlenstoff und Stickstoff, Auscheidung der ruhenden Menschen, "Archiv f. Anat. u. Phys.," 1862.

† "Physiol. der Menschen," Ranke, p. 509.

‡ Brit. Med., Journ., 1870, p. 70.

II. Upon a strictly non-nitrogenous diet the observations are not numerous :—

Ranke found 8 grms.,*
and Von Franque 7·5 grms.

III. Professor Playfair attacked the question from another side, by collecting from various sources the minimum diets upon which man could live, and to which he gave the name of subsistence diets, and by calculation the amount of nitrogen contained in them. This method gave him as a mean 9·2 grms., but his patients were none of them at absolute rest, but were performing during the day a certain amount of work.† Edward Smith in the same way by calculation from the diets of the spinners during the cotton famine found a somewhat larger amount of nitrogen (12 grms.),‡ which agrees with the amount of nitrogen contained in Playfair's second class of small diets, but in all these cases the effect of muscular exertion is not eliminated.

IV. Unruh gives a series of three observations upon hospital patients kept at rest, and placed upon a restricted diet. Unfortunately he gives little description of the diet, except that it was fever diet, and consisted of beef-tea or broth, with an egg or two.

In the first, a case of cancerous obstruction, the amount of nitrogen was 8 grms. (17·5 urea). But this case is not altogether satisfactory from the amount of wasting accompanying this disease.

The other two were cases of syphilis placed upon fever diet, and kept at rest for the sake of the experiments; the first passed 8·6 grms. (18·6 urea), the second 7·5 grms. (16·2 urea).

The mean of these three cases is 8 grms. (17·5 urea).

The general results of the various series of observations may be roughly tabulated thus :—

I. Starvation. 8 grms.
II. Non-nitrogenous food. 8 grms.
III. Subsistence diet. 9 grms.
IV. Insufficient diet. 8 grms.
V. Clinical equilibrium. 8 grms.

A remarkable coincidence, considering the variety of the methods employed, and the different conditions under which the determinations were made.

We may therefore conclude that the minimum amount of nitrogen excreted by a healthy adult man is on the average 8 grms. in the 24 hours, this being equivalent to 17·5 grms., or to 260 grains of urea.

* Ranke (*ut supra*).
† "On the Food of Man in relation to his useful Work." Edinb., 1865.
‡ "Influence of Food," 1860.

Table IV.—Analysis of Food of Aneurism Patients.

	I.		II.
Solid food.			
Total weight	322·85	....	282·20
Water (loss at 115° C.)	188·43	....	157·90
Ash	0·94	....	3·50
C, H, and O (difference)	126·48	....	113·91
Nitrogen	7·00	....	6·89
	322·85		282·20
Liquids.			
Total weight	296·28	....	243·20
Water	288·92	....	237·10
Ash	0·32	....	0·23
C, H, and O (difference)	6·97	....	5·81
Nitrogen	0·07	....	0·06
	296·28		243·20
Total food (solids and liquid).			
Total weight	619·13	....	525·40
Water	477·35	....	395·00
Ash	1·26	....	3·73
C, H, and O (difference)	133·45	....	119·72
Nitrogen	7·07	....	6·95
	619·13		525·40

Table V.—Comparison of the Food, and of the Urine of the Aneurism Patients.

Ingesta (solid and liquid).	Analysis I.		II.
Water	477·35	....	395·00
Ash	1·26	....	3·73
C, H, and O (difference)	133·45	....	119·72
Nitrogen	7·07	....	6·95
Total	619·13		525·40

Diet (as given).

Solids.			
Meat	4 ozs., containing of nitrogen*	76	grains.
Bread.....	3 „ „ „	16·5	„
Potatoes	2 „ „ „	2·0	„
Butter	1 „ „ „	0·2	„
	10 ozs.	94·7	grains.
		or 6·3	grms.
Liquids.			
Water	4 ozs.		
Wine (port)	3 „		
Tea.....	3 „		
	10 ozs.		

Urine (the mean of each case).

	I.	II.	III.
Volume of urine	470 c.c.	490 c.c.	384 c.c.
Ash.....	5·264	6·125	6·26
C, H, and O (difference)	10·434	10·78	7·58
Nitrogen.....	8·601	8·624	6·374
Percentage of nitrogen as urea.	94·53	88·06	87·35

Urine percentage averages upon fixed diet.

	I.	II.	III.
Total nitrogen.....	1·83	1·76	1·66
N as urea	1·73	1·55	1·45
Solid residue	5·17	5·21	5·26
Ash.....	1·12	1·25	1·63
C, H, and O (difference)	2·22	2·2	1·974
Amount of urine	470 c.c.	490 c.c.	384 c.c.
Specific gravity	1028 „	1030 „	1029 „

* By calculation from tables given in Parkes' "Hygiene."